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Coordinated Eastern Arctic Experiment (CEAREX): Biological-Physical-Optical Cruise Data Report April 10 - May 17, 1989

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II. Note on relationship of printout to CEAREX optical disk database:

The following printout is for the Biological-Physical-Optical cruise (April 10- May 17, 1989) only. It consolidates data, with one page representing each station. The digital (CD-ROM, enclosed floppy disks) data files are organized as described in the Documentation Section (Section III.1)

The null values on the CEAREX CD-ROM provided by NSIDC, as specified by the following document (Section III), are set to blank on the enclosed database printout (Section IV). For some variables, the formats in the printout have fewer decimal places than the same variables in the CD-ROM (and the enclosed floppy disk).

Availability of bioluminescence, zooplankton and optical profile data are indicated in the printout with Y/N; the data are only available on the CD-ROM or the enclosed floppy disks.

III. Documentation for Biological-Physical-Optical Cruise

CEAREX, RV Polarbjorn
April-May 1989
B. Greg Mitchell

1. Introduction and File Descriptions

1.1. Structure and Contents of This File

The Biological-Physical-Optical cruise was carried out aboard RV POLARBJORN during April and May 1989 as part of the Coordinated Eastern Arctic Experiment (CEAREX). The data base from the cruise consists of 6 separate files, in ASCII character format:

STADB.DAT the database of each station
DEPTHDB.DAT the database of all bottle samples
ZOOPLKT.DAT the database of the zooplankton sampling
BIOLUM1.DAT the database of bioluminescence profiles
BIOLUM2.DAT the database of bioluminescence values at 10-meter intervals
PROFK.DAT the database of optics profiles

A description of each data file, including variable names, formats, and a brief description of each variable, is given in Section 1.2 of this documentation file. Each description includes the name of the investigator who provided the data and identifies the section of this document where the methods and/or references for the variables are described.

Six sections (2 - 7) follow the initial file descriptions. These sections contain the detailed descriptions of the methods and/or references, provided by the individual investigators (PIs), used to determine each variable type in the six data files listed above. The sections are:

2. Physical Oceanography, Dr. Thomas O. Manley, PI
3. Meteorological Data, Dr. Kenneth Davidson, PI
4. Nutrient Chemistry
    4.1. Major Dissolved Nutrients, Dr. Louis Codispoti, PI
    4.2. Biogenic and Lithogenic Silica, Dr. David Nelson, PI
5. Biological Analyses
    5.1. Phytoplankton and Particulates, Dr. Walker O. Smith, Jr., PI
    5.2. Zooplankton and Bioluminescence, Dr. Edward Buskey, PI
6. Optical Profiling and Particle Optics, Dr. B. Greg Mitchell, PI
7. Station Log Observations, Dr. H.J. Niebauer, PI

1.2. Description of the Data Base Files

Data format notes: Null values are provided in fields in the databases that may in some cases contain no data. The null value varies depending on the field. The null value for each field is given in the tables in Sections 1.2.1 through 1.2.5. Specified formats are for each field as written to the ASCII files on this CD-ROM. At least one blank separates each field, but there may be more than one blank between some fields.

1.2.1. Filename STADB.DAT - Station Log Data Base
These data are in the CD-ROM directory \BIOPHYS.

This file contains observations of data that have only one value at each station. Variables include time, location, flags for occurrence (or not) of ancillary data collection such as bioluminescence profiles, zooplankton tows or optics profiles, or integrated values of biological variables such as chlorophyll and primary production.

Field Name	Null Value	Fortran Format	Description
STA	N/A	I3	Station number (see Manley, Section 2)
ZOOSTA	N/A	A1	Zooplankton station flag (y/n) (see Buskey, Section 5.2)
BLSTA	N/A	A1	Bioluminescence station flag (y/n) (see Buskey, Section 5.2)
OPTSTA	N/A	A1	Optics station flag (y/n) (see Mitchell, Section 6)
MO	N/A	I2	Month of year (see Manley, Section 2)
DAY	N/A	I2	Day of month (see Manley, Section 2)
YR	N/A	I2	Year (see Manley, Section 2)
TIME	-9:-9	I2:I2	Time of day (see Manley, Section 2)
JULDAY	N/A	I3	Julian day (see Manley, Section 2)
LAT	-999	F8.4	Latitude (see Manley, Section 2)
LON	-999	F4.4	Longitude (see Manley, Section 2)
IntCHL	-9	F5.1	Chlorophyll-a integrated 0-150 m, mg m-2 (see Smith, Section 5.1.1)
IntPH	-9	F5.1	Phaeopigments integrated 0-150 m, mg m-2 (see Smith, Section 5.1.1)
IntPROD	-9	F6.1	Primary Production integrated from surface to depth at which 0.1% of surface irradiance penetrated (see Smith, Section 5.1.3)
AIRTEMP	-999	F5.1	Air temp., degrees C. (see Davidson, Section 3)
HUM	-9	F5.1	Relative Humidity (see Davidson, Section 3)
WNDSPD	-9	F5.1	Wind Speed, meters per sec. (see Davidson, Section 3
WNDHEAD	-9	F5.1	Wind Heading, degrees from true north (see Davidson, Section 3)
PRESS	-9	F6.1	Barometric Pressure, millibars (see Davidson, Section 3)
GRPLOG	-9	A37	Group station log (see Manley, Section 2)
HOOVLOG	-9	A118	"Hoover" Log (see Niebauer, Section 7)

1.2.2. File DEPTHDB.DAT - Bottle Depths Data Base
These data are in the CD-ROM directory /BIOPHYS.

This file contains data collected by profiling with the CTD and collecting water samples with the rosette. Values from the CTD include salinity, temperature and fluorescence as well as discrete analyses for biology, chemistry and particle optics.

Field Name	Null Value	Fortran Format	Description
STA	N/A	I3	Station # (see Manley, Section 2)
BOT	-9	I2	CTD bottle number (see Manley, Section 2)
NBPR	-9	F6.1	Neil Brown Pressure (see Manley, Section 2)
BioZ	-9	I3	Biology "Nominal Depth" (see Smith, Section 5.1)
BioB	-9	I3	Biology Bottle # (see Smith, Section 5.1)
NB_TE	-9	F6.3	Neil Brown Temp. (see Manley, Section 2)
NB_SA	-9	F6.3	Neil Brown Salinity (see Manley, Section 2)
NB_FL	-9	F6.3	Neil Brown Fluorescence (see Manley, Section 2)
PO4	-.99	F4.2	Phosphate (see Codispoti, Section 4.1)
Si	-9	F5.2	Silicate (see Codispoti, Section 4.1)
NO3	-9	F5.2	Nitrate (see Codispoti, Section 4.1)
NO2	-.99	F4.2	Nitrite (see Codispoti, Section 4.1)
BioSi	-9	F8.3	Biogenic Silica (see Nelson, Section 4.2)
LithoSi	-9	F8.3	Lithogenic Silica (see Nelson, Section 4.2)
CHLa	-.99	F5.2	Chlorophyll-a (see Smith, Section 5.1)
PHEO	-.99	F4.2	Phaeopigments (see Smith, Section 5.1)
POC	-9	F7.2	Particulate organic carbon (see Smith, Section 5.1.2)
PON	-9	F6.2	Particulate organic nitrogen (see Smith, Section 5.1.2)
PROD	-9	F6.2	Primary Production (see Smith, Section 5.1.3)
AP410	-.99	F6.4	Particulate absorption at 410 nm (see Mitchell, Section 6)
AP435	-.99	F6.4	Particulate absorption at 435 nm (see Mitchell, Section 6)
AP441	-.99	F6.4	" 441 nm
AP488	-.99	F6.4	" 488 nm
AP520	-.99	F6.4	" 520 nm
AP565	-.99	F6.4	" 565 nm
AP633	-.99	F6.4	" 633 nm
AP675	-.99	F6.4	" 675 nm
AP683	-.99	F6.4	" 683 nm
STATION COMMENTS		A40	General comments regarding a station

1.2.3. File ZOOPLKT.DAT - Zooplankton Data Base
These data are in the CD-ROM directory \BIOPHYS.

This file contains the results of enumeration of zooplankton collected by net tows. The samples were collected with oblique tows with a .5 meter diameter 153 um mesh net hauled between the surface and 150 meters. Values in the data file are the mean densities for replicate tows. Heading titles correspond to the categories in the table below; all values are floating point format. The Fortran format of the header record is 29(A10,1X). The format of the data records is 29(F10.2,1X). Values are number of observations of zooplankton groups per cubic meter (m**3)

Field Name	Description (See Buskey, Section 3, for details)
Station	CEAREX Station Number
Cff	Calanus finmarchicus adult females (m**3)
Cfm	Calanus finmarchicus adult males (m**3)
Cfj	Calanus finmarchicus juveniles (copepodites) (m**3)
Cgf	Calanus glacialis adult females (m**3)
Cgj	Calanus glacialis juveniles (copepodites) (m**3)
Chf	Calanus hyperboreus adult females (m**3)
ChCV	Calanus hyperboreus copepodite 5 (m**3)
Chj	C. hyperboreus juveniles (copepodites <5) (m**3)
Cbore	Conchoecia borealis (m**3)
Eham	Eukronia hamata (m**3)
Frit	Fritillaria sp. (m**3)
Mlf	Metridia longa adult females (m**3)
Mlm	Metridia longa adult males (m**3)
Mlj	Metridia longa juveniles (copepodites) (m**3)
Microf	Microcalanus sp. adult females (m**3)
Microj	Microcalanus sp. juveniles (copepodites) (m**3)
Oithf	Oithona spp. adult females (m**3)
Oithm	Oithona spp. adult males (m**3)
Oithj	Oithona spp. juveniles (m**3)
Oiko	Oikopleura spp. (m**3)
Para	Parathemisto sp. (m**3)
Pseuf	Pseudocalanus minutus adult females (m**3)
Pseuj	Pseudocalanus minutus juveniles (m**3)
Thys	Thysanoessa sp. (all developmental stages) (m**3)
Cnaup	Copepod nauplii (m**3)
Cegg	Copepod eggs (m**3)
OthCop	Other copepods (m**3)
OthZoo	Other zooplankton (m**3)

1.2.4. Files BIOLUM1.DAT and BIOLUM2.DAT - Bioluminescence Data Base
These data are in the CD-ROM directory \BIOPHYS.

1.2.4.1. BIOLUM1.DAT contains vertical profiles of mechanically stimulable bioluminescence obtained using a High Input Defined Excitation (HIDEX) type bathyphotometer. See Section 5.2.2 for details of the instrumentation and sampling.

Data were averaged at 5 meter intervals. Data from the top five meters were discarded. Values are in photons (*E10) per cubic meter. There were no CEAREX CTD stations numbered bp1700 and bp2300 for the second and third casts during the second drift. These station numbers in the data set refer to times when the BP and nets were deployed but no CTD was operating.

Header records 1 through 3 have the Fortran format 21(A7,1X). Header record 4 Fortran format is A7,161X. Data record Fortran format is 21(F6.1,1X). "1X" indicates one blank between each field in the headers and data records.

Header:

Station -> Sta X Sta Y Sta Z...etc...
Date -> Date X Date Y Date Z...etc...
GMT -> GMT X GMT Y GMT Z...etc...

Data: Density of photoplankton group per cubic meter.

Depth	Signal 1	Signal 2	Signal 3 ...etc...
F6.1	F6.1	F6.1	F6.1 ...etc...
F6.1	F6.1	F6.1	F6.1 ...etc...
F6.1	F6.1	F6.1	F6.1 ...etc...
.			
.			
etc.			

1.2.4.2. The file BIOLUM2.DAT contains vertical profiles of mechanically stimulable bioluminescence data from Stations 66, 69, 71 and 73. At these stations, the BP was stopped at 10 meter intervals and the pump was run for 5 minutes at each depth. This is the only difference between the data for these stations and the data in the file BIOLUM1.DAT. These four stations are provided in a separate file because the significantly shorter record length was difficult to integrate with the larger records in BIOLUM1.DAT. The format of the header records 1 through 3 is 4(A7,1X); the format of header record 4 is A7,25X. The data record format is 4(F6.1,1X).

1.2.5. File PROFK.DAT - Spectral K Data Base
These data are in the CD-ROM directory \BIOPHYS.

This file contains values for the spectral diffuse attenuation coefficient (k per meter) derived from vertical profiles of downwelling spectral irradiance. All optics data are in units per meter. The variable 'k' for all fields below is the diffuse attenuation coefficient for the designated wavelength.

Field Name	Null Value	Fortran Format	Description (see Mitchell, Section 5, for details)
MERcast	N/A	A6	Station name of the optics profile
Sta	N/A	I3	CEAREX Biophys cruise station number
Zm	N/A	I3	Depth in meters from the surface
C	N/A	F6.3	Beam attenuation coefficient, per meter
k-410	-.99	F7.3	k at 410 nm, per meter
k-441	-.99	F7.4	k at 441 nm, per meter
k-488	-.99	F7.4	k at 488 nm, per meter
k-520	-.99	F7.4	k at 520 nm, per meter
k-565	-.99	F7.4	k at 565 nm, per meter
k-633	-.99	F7.4	k at 633 nm, per meter
k-683	-.99	F7.4	k at 683 nm, per meter

2. Physical Oceanography - Dr. T.O. Manley

2.1. CTD data collected and processed by Tom Manley were provided for this CD-ROM volume. Comparison data used in quality control were extracted from his file called COMPAR.LOG (on this CD-ROM in the directory \HYDROG\BIOCTD), and were integrated into the bio-physical database for the discrete depths sampled. The data were extracted at depths decimated at 1 meter, smoothed, and interpolated as described in Section 2.3 below.

For the bio-physical data base, ONLY CTD DATA FOR THE DEPTHS OF THE WATER SAMPLES ARE INCLUDED. The final CTD data set for the bio-physical cruise is included in the hydrography data base, on this CD-ROM in the directory \HYDROG\BIOCTD.

Variables (and their accompanying definitions) that were extracted from COMPAR.LOG and subsequently used in this data base, file DEPTHDB.DAT, are listed below.

NB_PR => Neil Brown PRessure - (final data) the closest Neil Brown pressure to the actual pressure (TF_PR) at which the bottle was actually tripped (e.g. TF_PR = 34.7 db; NB_PR = 38)

NB_TE => Neil Brown TEmperature (final data) at NB_PR

NB_SA => Neil Brown SAlinity (final data) at NB_PR

NB_FL => Neil Brown FLuorometer value (final data) at NB_PR

2.2. Documentation for Tom Manley's file COMPAR.LOG

The file COMPAR.LOG (on this CD-ROM in the directory \HYDROG\BIOCTD) compares the trip log information obtained as each bottle was tripped and reported in the file TAGNEW (on this CD-ROM in the directory \HYDROG\BIOCTD) and bottle salinities with the final processed CTD/fluorescence profiles. This file was used as a form of quality control on the final data and did indeed reveal important information for the user. The notes that follow are important to understanding and using the data.

2.2.1. Station 165 shows a trip-final temperature difference of 0.651 degrees C. This has NOT been modified for the following reasons. Although the original log sheet and the trip file do confirm the 1.88 degree C temperature, the uptrace file shows no indication of such temperatures. Looking at the original plot, it appears that the 1.8 degree C water is almost the last depth level plotted. All other temperatures shown in the original plot are in the 1.2 degree C range and agree with the Neil Brown final temperatures (NB_TE). This is not a confusion of stations since the profiles (original and final) match except for this upper level temperature of 1.8 degree C. I concede that the high temperature was there, however, it must obviously be slightly above where the uptrace profile was terminated by the software. Further, one may want to show how different the surface trips can be (perhaps due to the proximity of the ship and its engine coolant outlets, on the same side as was used to lower the CTD) by looking at station 168

results which had two duplicate trips at 2 db with differences between the RECORD_TAG information of 0.4 deg. C!!!!

2.2.2. Stations 197 to 199 show the small but noticeable effect of a broken thermistor in the differences (DEL_TE) between the record tag observations (TF_TE) and the final data (NB_TE) when temperatures were positive. This resulted in an offset of about 0.08 degree C that was later corrected for in the final data.

2.2.3. When the thermistor was replaced after station 198, stations 199 to 212 show a rather obvious temperature mismatch of approximately 0.4 degree C between the record tag observations (TF_TE) and the final data (NB_TE) when temperatures were positive. These varying offsets were later corrected for in the final data.

2.3. CTD Data Processing - Tom Manley

Although this may appear to be a long document on how things were done, I would strongly recommend that you read it in its ENTIRETY. If you are knowledgeable about how the data were processed, you will better understand what can and can not be 'obtained' from the data set.

2.3.1. Contents of the Data Set

2.3.1.1. All of the CEAREX bio-ctd stations are labeled XXX.BIO, where XXX ranges from 002 to 212. Station 1 was not even considered since it was an exceptionally bad TEST station.

2.3.1.2. The updated edition of the tagfile is \HYDROG\BIOCTD\TAGNEW. Its first version was shipped out to everyone some time ago. All modifications since the last issue of the file to this date (March 1991) are labeled with the symbol '@' as the last character of the line.

2.3.1.3. The file \HYDROG\BIOCTD\COMPAR.LOG was used as one of the quality control steps. This file may be of more use to you than TAGNEW in that it incorporates the final data and compares it with the record tag (bottle trip) information.

2.3.1.4. A station listing file called BIOSTA.LOG (on this CD-ROM in the directory \HYDROG\BIOCTD) that lists all of the positions and times of the stations, is more or less useful for quick reference.

2.3.2. Data Processing Steps

2.3.2.1. Downtrace processing was rejected due to too many unexplainable hysteresis problems between the down and up traces. Uptraces were chosen because they could be calibrated to much higher standards since bottles were taken on these profiles.

2.3.2.2. Bulk salinity calibration was abandoned because of strong variations between stations and because of the exceptional stability of the temperature-salinity curve generated using calibrated Neil Brown temperatures and BOTTLE salinities.

2.3.2.3. Temperature was entirely bulk-calibrated, since there was no direct evidence of time variation, except when the first response thermistor was replaced at station 197. A very small correction was used for stations 2 through 196.

2.3.2.4. Pressure calibration equations were generated for both uptrace and downtrace using a bulk processing method. However, pressure offsets were calculated individually for each station to get the best near surface information for the biological work as well as to provide the best intercomparison with the MER (G. Mitchell's bio-physical sensor) observations. Station 196, due to its depth of approximately 2500 db, had its own pressure calibration.

2.3.2.5. University of Rhode Island (URI) provided a week of programming time and two weeks of microVAX time (at no cost) to reprocess all of the up and down traces from the original digital data. The reprocessing included temperature and pressure calibrations. Salinity was then derived with the newly-calculated p, t and c. Nothing was done to fluorometry or conductivity.

2.3.2.6. Station 151 was re-derived from audio data and was later reprocessed by URI.

2.3.2.7. Processed uptraces were still quite noisy due to dragging instrumentation through the water column (i.e. the sensors reading some of the more nasty turbulent wake effects.) Filtering was done to smooth out these turbulent effects.

2.3.2.8. Both the top and bottom of the profiles were inspected to make sure that the data seemed reasonable. In several stations, a bad point was included that would make a mess of the filtering process. If bad data were observed, they were replaced with data along a similar trend using the original plotted data and the uptrace plot and/or, very rarely, the downtrace as a framework.

2.3.2.9. Two uptrace profiles were deemed unusable: station 117 and station 164. Station 127 had a repairable section of data missing and was salvaged using the downtrace information.

2.3.2.10. Initially, a median filter of 20 points and then a Gaussian filter of 30 points was used. This turned out to be too `heavy-handed' and a better method of 4 successive 10-point Gaussian passes was used. Glen Cota and I agreed on this as the best compromise for fluorescence as well as CTD work. Additionally, this provided a reasonable fluorometry profile, as opposed to some of the original profiles that looked more like a `shotgun' pattern. By the very nature of filtering, top and bottom parts of the profile (if in high gradient regions) will be off from the original characteristic conditions of the uptrace. Deviations of this kind were checked at the very end of the processing phase of quality control using the COMPAR.LOG file (i.e. comparing final data against original record tag trips). Please read the introduction to the COMPAR.LOG file to get an appreciation for these errors (Section

2.2, above). In short, these errors were minimal especially compared to the variability of the data within the record tag file itself (see the FT_VAR column in the COMPAR.LOG file.) With respect to the other high gradient regions such as the thermo/halo/pycnoclines, there will be deviations. This is not totally desirable, however it was a trade-off that I was willing to make to get the hydrographic information into a more intelligible form. The deviations in the `clines' can be also seen in the COMPAR.LOG file.

2.3.2.11. The correction of the `broken thermistor' data at Stations 197 through 212 was completed.

2.3.2.12. T,S, density and FL profiles were plotted for all of the stations. Since many of the stations have very little density variation in them, inversions, obviously a major source of problems, were easily detected. Many of the inversions were created solely because of a temperature/conductivity lagging mismatch. We did not have time to investigate this at URI, so the data were processed using generic lagging concepts. The lagging mismatch, the noisy nature of the data, and the potential for bio-fouling (Phaeocystis) gumming up the conductivity cell in certain high biomass regions, lead me to believe that the density inversions were an artifact of the above-mentioned problems and therefore COULD NOT BE CONSIDERED AS REAL PHYSICAL PROCESSES occurring in the ocean. For this reason, all density inversions were removed BY HAND to ensure the proper gradient characteristics of the original density field were preserved.

2.3.2.13. A major problem was then discovered: There was an obvious and CONSISTENT density inversion (approximately 0.006 sigma-0 units) observed at the transition from positive to negative temperatures (i.e. at 0 degrees C.) This problem should have been detected at the beginning and corrected BEFORE all of the filtering since the 0 degree density shift was subsequently `smeared' by the filtering process. Instead of starting from scratch, an attempt was made to fix the `generic' problems with some creative software. Surprisingly, the program worked better than had been expected, and all of the stations were realigned. Only stations 2 through 196 were done this way. Stations 197 through 212 had already been (unwittingly) corrected for this problem since it had manifested itself to extreme proportions because of the broken thermistor. It should also be noted that the temperature error that caused this 0.006 density inversion problem was on the order of 0.005 degrees C, which upon recalculation of salinity and then density (like a positive feedback loop) caused the observed density problem. The opposite effect was also observed (i.e. - a positive increase in density of 0.006 during the transition from negative to positive temperatures). These were more difficult to find since this transition was typically masked by the high gradient in the thermocline/pycnocline but in several profiles where this was not the case, it was observable. All positive temperatures were too warm by 0.005 degree C so their salinity profiles, etc., were also off. The program took all this into account so that ALL of the profiles can be considered similar in their makeup.

2.3.2.14. After verification of acceptable density structure at both the

top and bottom of the profile, three techniques were tried for salinity calibrations. These were: 1) calibrating the purely independent channel of conductivity through the bottle salinity; 2) calibrating salinity as a function of the bottle salinity; 3) calibration of salinity as a function of pressure. Both 1 and 2 proved to be completely unsatisfactory while 3 proved to be the most acceptable. Additionally, the clean nature of the bottle salinity plotted against corrected Neil Brown temperature on a T-S curve gave exceptionally high credibility to the calibration of salinity on a per station basis. Of the DEEP bottles that fell off of the tight T-S curve, all had justification for being that way oceanographically (at virtually all points there was indication of deep water ventilation - chimneys, cold pool survey, and the like). So they remained as part of the calibration. Calibration for most of the stations was calculated using linear regression of the difference between the bottle salinity and the filtered and corrected Neil Brown data against their respective pressures, which of course provides a perfect fit given two x,y pairs. Only Station 196 had three salinity bottles taken. Using this station as a test case, a linear equation was generated with only the top and bottom information. The intermediate value was then solved for and compared with the actual value. The resulting error of 0.005 psu (see COMPAR.LOG Station 196 for this result) confirmed the linear method and additionally gave the best indication of accuracy of the data, this being less than 0.006 psu. Note that the 0.006 psu accuracy is ONLY for those stations that had both bottom and top bottle salinities available. About 82% of the data fall within these conditions. Those stations that have only one bottle or no bottles were provided extra information from the bounding stations (in time) to come up with the required equation. For those stations that had one bottle, accuracy is estimated to be on the order of 0.015 psu. For stations that had no bottles, accuracy would be on the order of 0.025 psu.

The stations that fall into the 0.015 psu accuracy are 19, 46, 47, 57, 73, 102, 105, 106, 107, 114, 127, 129, 152, 153, 154, 155, 156, 165, 168, 190, 195, 201, and 202.

The stations that fall into the 0.025 psu accuracy are 2, 3, 11, 15, 29, 30, 40, 49, 60, 67, 82, 92, 94, 103, and 104.

All remaining stations have the higher 0.006 psu accuracy.

2.3.2.15. After salinity calibration was applied, plots were then made to verify the validity of the equation for each station. Several stations were found to have bad (primarily surface) bottle data when compared to the bounding station information and were therefore discarded. New equations were then made and retried. This iterative method was only used on about 8 stations and each was correctly calibrated on the second pass.

2.3.2.16. All profiles went though visual editing to insure the removal of all density inversions. If I don't believe them, I won't let other people suffer through them! New salinities were then 'back-solved' from the corrected density and unaltered pressure and temperature values.

2.3.2.17. T-S plots of all of the stations proved to be another quality control technique. Station 212 was found to be in error serendipitously. An autosal typographical error was found that gave the low salinity that in turn made the delta S look like all of the other `normal' stations. This was taken care of. Freezing temperature quality control also proved to be exceptionally useful in that no data values fell below the freezing point.

2.3.2.18. All of the station headers were redone to reflect the start time and position of the uptrace (or downtrace where applicable.) This was done on the basis of the original log sheets. Uptrace position was defined to be the average of the beginning and ending latitude and longitude.

2.3.2.19. The COMPAR.LOG file was the last quality control check (see the file for details) which also turned up one station, or I should say the lack of one station, in error. Station 151 was actually Station 150! Since Station 151 was the audio tape station and was difficult to get reprocessed (and I didn't want to hold the data back any more - at least not for one station), I decided to use the downtrace version and apply salinity calibration to the data based on the uptrace tag file information. This also proved to be acceptable. As it turns out, Station 151 did not have that large a deviation from the uptrace.

2.3.2.20. The parameters of potential temperature and dynamic height were added to each station.

2.3.2.21. The station file headers are explained below. The example shown here is for Station 002.BIO, with the actual data values at the beginning of the station given in the example.

```
 CPB32   2 2 78.5403   9.3690 89/04/10 100 12:29  PB5
PR    TE     SA      FL     PT      S0      HZ
7.0   0.140  34.214  1.206  0.140   27.464  0.004
8.0   0.145  34.216  1.271  0.145   27.466  0.005
9.0   0.150  34.218  1.339  0.150   27.467  0.005
```

The first line (a traditional file header) can be broken down as:

CPB32 - ship id code
2 - station number
2 - uptrace cast used; if value is 1, a downtrace was used
78.5403 - decimal latitude
9.3690 - decimal longitude (East is positive, West is negative)
89/04/10 - year/month/day
100 - relative Julian day (year-day)
12:29 - recorded log sheet time at beginning of uptrace or downtrace
PB5 - CEAREX cruise number id for the bio/phys/oceanog phase

The second line (data column headers) can be broken down as:

PR - pressure in db
TE - temperature in degrees C
SA - salinity in psu
FL - uncalibrated, but very close to correct, according to Glen Cota; units are mg/l
PT - potential temperature in degrees C
S0 - Sigma-0 or potential density
HZ - dynamic height anomaly in dyn. m. using the surface (0 db) as the reference level; the first value in the data (if not at 0 db) is used to represent the surface parameters.

2.4. Conclusion

Time, and use of the data, will find any remaining errors. Please let me [T. Manley] know of any problems that are encountered so they can be investigated and corrected in later versions of the data set.

3. Meteorological Data for Bio-Physical Stations - Dr. K. Davidson

3.1. Meteorological Data Description

Note: ONLY DATA FROM THE POLARBJORN AT THE TIME OF THE BIO-PHYSICAL STATIONS WERE EXTRACTED AND INCLUDED IN THIS DATA BASE. A PC diskette containing the CEAREX hourly meteorological data is available from NSIDC. The complete CEAREX ten-minute meteorological data are contained on this CD-ROM in the directory \METEOR.

The file provided by K. Davidson contains observations taken during the Coordinated Eastern ARctic EXperiment (CEAREX). The data consist of hourly averaged observations of wind speed, wind direction, air temperature, relative humidity and sea level pressure. The hourly averaged values were calculated from ten-minute averaged values. Wind data were converted into u and v components, averaged, and then converted back into speed and direction.

Note: THE FOLLOWING VARIABLE SYMBOLS ARE DIFFERENT THAN THOSE ORIGINALLY PROVIDED BY K. DAVIDSON. THE FOLLOWING SYMBOLS ARE THE ONES USED IN THE BIO-PHYSICAL DATABASE, FILE STADB.DAT:

WNDSPD = wind speed in meters per second;
WNDHEAD = wind direction in degrees from true north;
AIRTEMP = air temperature in degrees C;
HUM = relative humidity in percent;
PRESS = sea level in millibars.

Missing values are coded as -9, except AIRTEMP, coded as -99 if missing. Note that there are gaps in the data records where observations are missing and there is no entry for one or more date/time group.

3.2. Reference

Lackmann, G.M.; P.S. Guest; K.L. Davidson; R.J. Lind and J. Gonzales (1989) CEAREX/POLARBJOERN Meteorology Atlas. Naval Postgraduate School, NPS-63-89-005, 545 p.

4. Nutrient Chemistry

4.1. Major Dissolved Nutrients - Dr. L. Codispoti

4.1.1. Data Description

These 1980 CEAREX nutrient observations were taken in Fram Strait from the R/V POLARBJORN between 10 April and 17 May 1989. The samples whose concentrations are reported here were obtained during the biological Niskin bottle casts. A six-channel Alpkem Rapid Flow Analyzer "mated" to a computer-controlled (HP Vectra ES/12) data acquisition system performed the nutrient analyses. The methods used for the ammonium, nitrate, nitrite, phosphate and silicate analyses were slight modifications of the methods described by Sakamoto et al., 1990 ("MBARI procedures for automated nutrient analyses using a modified APKEM Series 300 Rapid Flow Analyzer," MBARI Technical Report 90-2).

Some problems were encountered with the ammonium method, so we have not included these data here. These data, although useful, require additional editing. Consequently, investigators wishing to use the ammonium data should contact us directly. The nitrate, nitrite, phosphate and silicate data are reported as NO2, NO3, PO4, and Si in micromolar.

So far, the nutrient data have gone through three stages of editing, but some errors may remain. We urge the user to contact us if they encounter suspicious values, and we are continuing to improve the already-acceptable quality of these data. At the present stage of editing, we estimate the accuracy of the PO4 data to be plus or minus 0.06 micromolar, and the nitrite data to be plus or minus 0.04 micromolar. We estimate the accuracy of the silicate and nitrate data to be plus or minus about 4%. These accuracy estimates are for the entire suite of data. Precision within any given cast is considerably better. The accuracy estimates may improve with further editing.

A pumping system based on the system described by Friederich et al., 1989 ("Bottle and pumpcasts data from the 1988 Black Sea Expedition," MBARI Technical Report 90-3) and Codispoti et al., 1991 ("Chemical variability in the Black Sea: Implications of continuous vertical profiles that penetrated the oxic/anoxic interface," Deep Sea Research, in press) was used to obtain a few continuous vertical nutrient profiles. These data require further editing before they can be distributed, but interested parties can contact us directly for preliminary copies.

4.1.2. References

Codispoti, L.A., G.E. Friederich, J.W. Murray and C.M. Sakamoto (1991, in press) Chemical variability in the Black Sea: Implications of continuous vertical profiles that penetrated the oxic/anoxic interface. Deep-Sea Research.

Friederich, G.E., L.A. Codispoti and C.M. Sakamoto (1990) Bottle and Pumpcasts Data from the 1988 Black Sea Expedition. MBARI Technical Report 90-3.

Sakamoto, C.M., G.E. Friederich and L.A. Codispoti (1990) MBARI Procedures for Automated Nutrient Analyses Using a Modified Alpkem Series 300 Rapid Flow Analyzer. MBARI Technical Report 90-2.

4.2. *Biogenic and Lithogenic Silica* - Dr. D. Nelson

4.2.1. Procedures

Biogenic silica was determined by filtering seawater through 0.6 um Nuclepore filters, drying them and returning them to OSU for analysis. Back in the lab, the filters were digested in hot NaOH to dissolve the biogenic silica (Paasche, 1973, Marine Biology, 19(2), p. 117-126; and Krausse, et al., 1983, Freshwater Biology, 13(1), p. 73-81) and the resulting solution was analyzed for reactive silicate by the acid-molybdate method of Strickland and Parsons (Practical Handbook of Seawater Analysis, 1972). These same filters were subsequently digested in 0.2 mls of 2.9M HF acid in order to dissolve the lithogenic silica (Eggimann and Betzer, 1976, Analytical Chemistry, 48(6), p. 886-890). This solution was diluted to an HF concentration of less than 8mM and analyzed by the above acid-molybdate method.

4.2.2. References

Eggimann, D.W. and P.R. Betzer (1976) Decomposition and analysis of refractory oceanic suspended materials. Analytical Chemistry, 48(6), p. 886-890.

Krausse, G.L.; C.L. Schelske and C.O. Davis (1983) Comparison of three wet-alkaline methods of digestion of biogenic silica in water. Freshwater Biology, 13(1), p. 73-81.

Paasche, E. (1973) Silicon and the ecology of marine plankton diatoms. I. Thalassiosira pseudonana (Cyclotella nana) grown in a chemostat with silicate as limiting nutrient. Marine Biology, 19(2), p. 117-126.

Strickland, J.D.H. and T.R. Parsons (1972) Practical Handbook of Seawater Analysis. Canada. Fisheries Research Board. Bulletin 167, 311 p.

5. Biological Analyses

5.1. Phytoplankton and Particle Analysis - Dr. W.O. Smith, Jr.

Data collected during CEAREX included variables which describe phytoplankton and particulate matter concentrations. They include pigment (chlorophyll and phaeophytin) concentrations, particulate carbon, and particulate nitrogen. Also measured was the rate of primary productivity. Variables in the data file are:

CHL Variable 1 is chlorophyll concentration in ug/l
PHEO Variable 2 is phaeophytin concentration in ug/l
POC Variable 3 is particulate organic carbon in ug/l
PON Variable 4 is particulate organic nitrogen in ug/l
PROD Variable 5 is primary productivity in ug C/l/d.

Following are brief descriptions of the procedures used for each analysis.

5.1.1. Pigments: Chlorophyll and phaeophytin were determined fluorometrically on a Turner Designs Fluorometer Model 10 (Holm-Hansen et al., 1967, "Fluorometric determination of chlorophyll," J. Cons. Perm. Int. Explor. Mer, 30, p. 3-15; Parsons et al., 1984, Manual of Chemical and Biological Methods for Seawater Analysis, NY, Pergamon Press), which had been calibrated with commercially purified chlorophyll-a (Sigma Chemical). Filters were extracted in 90% acetone, sonicated for 10 minutes, and the fluorescence was assayed before and after acidification.

5.1.2. Particulate carbon and nitrogen: Particulate matter concentrations were determined by pyrolysis of filtered samples in a Perkin Elmer Model 240B elemental analyzer. Samples (ca. 0.3-1.1 l) were filtered through precombusted (450 C for 4 h) GF/F filters, rinsed with a few ml of weak (0.01 N) HCl, placed in precombusted glass vials and covered with aluminum foil, and dried at 60 C. Blanks were filters placed under another filter and processed as above (Nelson et al., 1989, "Particulate matter and nutrient distributions in the ice-edge zone of the Weddell Sea: Relationship to hydrography during late summer," Deep Sea Research, 36, p. 191-209).

5.1.3. Primary productivity: Rates of primary productivity were determined using simulated in situ 14C-incorporation experiments (Smith and Nelson, 1990, "Phytoplankton growth and new production in the Weddell Sea marginal ice zone in the austral spring and autumn," Limnol. Oceanogr., 35, p. 809-821). Samples were collected from depths which corresponded to known percentages of surface irradiance and placed in bottles covered with neutral density screens. The samples were inoculated with ca. 20 uCi of HCO3 and incubated on deck for ca. 24 h. Incubations were terminated by filtering the samples through GF/F filters, which were rinsed with 5 ml 0.1N HCl just prior to the completion of the filtration (Goldman and Dennett, 1985, "Susceptibility of some marine phytoplankton species to cell breakage during filtration and post-filtration rinsing". J.Exp. Mar. Biol. Ecol., 86, p. 47-58). All samples were counted on a liquid scintillation counter, and counting efficiencies determined by the external standard method. Total added isotope was determined by counting 0.5 ml of unfiltered sample directly.

Integration was from the surface to the depth at which 0.1% of surface irradiance penetrated. This depth varies for each station.

5.1.4. References

Goldman, J.C. and M.R. Dennett (1985) Susceptibility of some marine phytoplankton species to cell breakage during filtration and post-filtration rinsing. J. Exp. Mar. Biol. Ecol. 86, p. 47-58.

Holm-Hansen, O., C.J. Lorenzen, R.W. Holmes and J.D.H. Strickland (1965) Fluorometric determination of chlorophyll. J. Cons. Perm. Int. Explor. Mer 30, p. 3-15.

Nelson, D.M., W.O. Smith, Jr., R. Muench, L.I. Gordon, D. Husby and C.W. Sullivan (1989) Particulate matter and nutrient distributions in the ice-edge zone of the Weddell Sea: Relationship to hydrography during late summer. Deep-Sea Research, 36, p. 191-209.

Parsons, T.R., Y. Maita and C.M. Lalli (1984) Manual of Chemical and Biological Methods for Seawater Analysis. NY: Pergamon Press.

Smith, W.O., Jr. and D.M. Nelson (1990) Phytoplankton growth and new production in the Weddell Sea marginal ice zone in the austral spring and autumn. Limnol. Oceanogr., 35, p. 809-821.

5.2. Zooplankton and Bioluminescence - Dr. E. Buskey

5.2.1. The file ZOOPLKT.DAT contains the results of enumeration of zooplankton obtained by net tows. The samples were collected with oblique tows with a 0.5 meter diameter 153 um mesh net hauled between the surface and 150 m. Numbers included in the database are the mean densities for replicate tows. Each field represents the results for a species, a species developmental stage, or an aggregate of organisms not identified to the species level. All variable symbols are defined in Section 1.2.3, "File ZOOPLKT.DAT - Zooplankton Data Base".

5.2.2. The files BIOLUM1.DAT and BIOLUM2.DAT contain vertical profiles of mechanically stimulable bioluminescence data obtained using a High Input Defined Excitation (HIDEX) type bathyphotometer. The design was based on the NORDA HIDEX. A 220 volt stainless steel well pump (Crown pumps) was used to pump 100 gallons per minute through our detection chamber. Bioluminescence was stimulated by the shear created as the flow of seawater passed through a 1 cm**2 grid at the intake to the detection chamber. The walls of the detection chamber are lined with optical fibers that collect light from the entire detection chamber and direct it to the photomultiplier tube (PMT) in the MER-2050 profiling bioluminescence photometer (BP) (Biospherical Instruments, Inc). This instrument samples voltages at the photomultiplier tube at a sampling interval of 1 microsecond. Through a shipboard computer, the instrument is directed to sample the PMT a specified number of times, and then to sample any other sensors. In this case the only other parameters sampled were voltage to the PMT and depth. Typically, these parameters were sampled at 1 second intervals. The MER-2050 allows for the high voltage to

the PMT to be set at four levels: off (0 volts), low (500 volts), medium (700 volts) and high (900 volts), with higher voltages resulting in increased sensitivity. The BP was usually operated at its highest sensitivity, except in highly bioluminescent waters where bioluminescence was too bright to be accurately measured at the highest sensitivity.

The file BIOLUM1.DAT contains data averaged at 5 meter intervals. Data from the top five meters were discarded. Values are in photons (*E10) per cubic meter. The variables in this file are defined in Section 1.2.4, "Files BIOLUM1.DAT and BIOLUM2.DAT, Bioluminescence Data Base".

The file BIOLUM2.DAT contains data from Stations 66, 69, 71 and 73. At these stations the BP was stopped at 10 m intervals and the pump was run for 5 minutes at each depth. The variables in this file are also defined in Section 1.2.4, "Files BIOLUM1.DAT and BIOLUM2.DAT - Bioluminescence Data Base".

6. Optics - Dr. G. Mitchell

6.1. Particle Optics

Marine particulate absorption and fluorescence excitation spectra were determined according to the methods of Mitchell and Kiefer, 1984 ("Determination of absorption and fluorescence excitation spectra for phytoplankton." In: Marine Phytoplankton and Productivity, L. Bolis et al., Springer-Verlag; and, "Chlorophyll-a specific absorption and fluorescence excitation spectra for light limited phytoplankton," Deep Sea Research, 35, p. 639-663, 1988) and Mitchell, 1990 ("Algorithms for determining the absorption coefficient of aquatic particulates using the quantitative filter technique (QFT)". In: Ocean Optics X, R. Spinrad, ed., SPIE). Briefly, from 0.5 to 2.0 liters of seawater collected in the rosette Niskin bottles (see Section 1.2.2) was filtered through Whatman GF/F filters. The particles concentrated on the filters were then analyzed in a spectrophotometer and spectrofluorometer. The analysis using the spectrophotometer provided the raw absorbance which was then corrected according to Mitchell, 1990 ("Algorithms for determining ...," In: Ocean Optics X, R. Spinrad, ed., SPIE) to determine the absorption coefficient of the particles in the sea water suspension. The method is considered to have an accuracy of +/- 15%. Absorption coefficients at selected wavelengths corresponding to the channels of the optical profiler (described in Section 6.2) are included in the data base. The spectral fluorescence data are not included in the data base.

6.2. Optical Profiling

6.2.1. Data Description

A bio-optical-physical profiler was deployed at approximately 25% of the CEAREX stations. The system is an integrated in situ profiler capable of measuring the following variables in continuous profile mode:

Auxiliary sensors:

Temperature	Sea Bird Electronics
Salinity	Sea Bird Electronics
Fluorescence	Sea Tech, Inc.
Transmission	Sea Tech, Inc

Optics sensors:

Surface PAR	Biospherical Instruments QSR-100
Profiled PAR	Biospherical Instruments MER 1012

Downwelling Irradiance — Biospherical Instruments MER 1012
410 nm
441 nm
488 nm
520 nm
565 nm
633 nm
683 nm

Upwelling radiance — Biospherical Instruments MER 1012
441 nm
488 nm
520 nm
565 nm
683 nm

All data from the profiler and the deck PAR sensor were integrated using a Biospherical Instruments multiplexing deck box. The digitized signal was transferred by RS-232 interface to an IBM-AT compatible computer.

A complete description of the profiler, data sampling and data processing can be found in Mitchell and Holm-Hansen, 1991 ("Bio-optical properties of Antarctic waters: Differentiation from temperate ocean models," Deep Sea Research, in press) or Mitchell, 1991 ("Predictive bio-optical relationships for polar oceans and marginal ice zones," Journal of Marine Systems, in press.)

6.2.2. References

Mitchell, B. G. and D. A. Kiefer (1984) Determination of absorption and fluorescence excitation spectra for phytoplankton. In: Marine Phytoplankton and Productivity, L. Bolis, R. Giles and O. Holm-Hansen, eds. Berlin: Springer-Verlag.

Mitchell, B. G. and D. A. Kiefer (1988) Chlorophyll a specific absorption and fluorescence excitation spectra for light limited phytoplankton. Deep-Sea Research, 35, p. 639-663.

Mitchell, B. G. (1990) Algorithms for determining the absorption coefficient of aquatic particulates using the quantitative filter technique (QFT). In: Ocean Optics X, R. Spinrad, ed. Bellingham, WA: Society of Photo-optical Instrumentation Engineers.

Mitchell, B. G. and O. Holm-Hansen (1991) Bio-optical properties of Antarctic waters: Differentiation from temperate ocean models. Deep-Sea Research, in press.

Mitchell, B. G. (1991) Predictive bio-optical relationships for polar oceans and marginal ice zones. Journal of Marine Systems, in press.

7. Station Observational Log - H.J. Niebauer

At each station notes on sea ice, sea state, cloud state and station type were recorded by a watch person. The data were entered into a personal computer file for subsequent qualitative assessment of each station.

8. Contact Information

If you encounter any problems with data in the files on this CD-ROM, please contact the CEAREX Bio-Optics Data Set Manager B. Greg Mitchell. All address are located on Principal Investigator list:

The Physical Oceanography data described in Section 2 were provided and documented by Dr. Thomas O. Manley.

The Meteorological data described in Section 3 were provided and documented by Dr. Kenneth Davidson and Dr. Peter Guest.

The Major Dissolved Nutrient data described in Section 4.1 were provided and documented by Dr. Louis Codispoti.

The Biogenic and Lithogenic Silica data described in Section 4.2 were provided and documented by Dr. David Nelson.

The Biological Analyses described in Section 5.1 were provided and documented by Dr. Walker O. Smith, Jr.

The Zooplankton and Bioluminescence data described in Section 5.2 were provided and documented by Dr. Edward Buskey.

The Optics data described in Section 6 were provided and documented by Dr. B. Greg Mitchell.

The Station Observational Log described in Section 7 was provided and documented by Dr. H. J. Niebauer.

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